

CLAIMS

What is claimed is:

1. A nano-multilayered structure suitable for use in high-temperature applications, comprising:

a plurality of metallic alloy layers, wherein the thickness of each of the plurality of metallic alloy layers is on a nano scale; and

a plurality of ceramic oxide layers disposed between the plurality of metallic alloy layers in an alternating manner, wherein the thickness of each of the plurality of ceramic oxide layers is on a nano scale.

2. The structure of claim 1, wherein each of the plurality of metallic alloy layers comprises a material selected from the group consisting of nickel aluminide, nickel aluminide doped with Hf, nickel aluminide doped with Zr, platinum aluminide and an MCrAlY alloy, wherein M comprises at least one of nickel, cobalt, iron and a combination thereof.

3. The structure of claim 1, wherein each of the plurality of ceramic oxide layers comprises at least one material selected from the group consisting of alumina, yttria, zirconia, yttria-stabilized zirconia, hafnia, a yttrium-based garnet and mullite.

4. The structure of claim 1, wherein the thickness of each of the plurality of metallic alloy layers and each of the plurality of ceramic oxide layers is between about 3 nm and about 200 nm.

5. The structure of claim 4, wherein the thickness of each of the plurality of metallic alloy layers and each of the plurality of ceramic oxide layers is between about 10 nm and about 100 nm.

6. The structure of claim 1, wherein the collective thickness of the plurality of metallic alloy layers and the plurality of ceramic oxide layers is between about 3 microns and about 200 microns.

7. The structure of claim 6, wherein the collective thickness of the plurality of metallic alloy layers and the plurality of ceramic oxide layers is between about 5 microns and about 150 microns.

8. The structure of claim 1, wherein the nano-multilayered structure comprises a nano-multilayered coating system.

9. The structure of claim 1, further comprising a substrate having a surface, wherein the plurality of metallic alloy layers and the plurality of ceramic oxide layers are disposed on the surface of the substrate.

10. The structure of claim 9, wherein the substrate comprises at least one of a nickel-based superalloy, a cobalt-based superalloy, an iron-based superalloy, and an MCrAlY alloy, wherein M comprises at least one of nickel, cobalt, iron and a combination thereof.

11. The structure of claim 9, wherein the substrate comprises a component of a gas turbine or an aircraft engine.

12. A high-temperature component, comprising:
a substrate having a surface; and
a nano-multilayered structure disposed on the surface of the substrate, the nano-multilayered structure comprising:
a plurality of metallic alloy layers, wherein the thickness of each of the plurality of metallic alloy layers is on a nano scale; and
a plurality of ceramic oxide layers disposed between the plurality of metallic alloy layers in an alternating manner, wherein the thickness of each of the plurality of ceramic oxide layers is on a nano scale.

13. The component of claim 12, wherein each of the plurality of metallic alloy layers comprises a material selected from the group consisting of nickel aluminide, nickel aluminide doped with Hf, nickel aluminide doped with Zr, platinum aluminide and an MCrAlY alloy, wherein M comprises at least one of nickel, cobalt, iron and a combination thereof.

14. The component of claim 12, wherein each of the plurality of ceramic oxide layers comprises at least one material selected from the group consisting of alumina, yttria, zirconia, yttria-stabilized zirconia, hafnia, a yttrium-based garnet and mullite.

15. The component of claim 12, wherein the thickness of each of the plurality of metallic alloy layers and each of the plurality of ceramic oxide layers is between about 3 nm and about 200 nm.

16. The component of claim 15, wherein the thickness of each of the plurality of metallic alloy layers and each of the plurality of ceramic oxide layers is between about 10 nm and about 100 nm.

17. The component of claim 12, wherein the thickness of the nano-multilayered structure is between about 3 microns and about 200 microns.

18. The component of claim 17, wherein the thickness of the nano-multilayered structure is between about 5 microns and about 150 microns.

19. The component of claim 12, wherein the nano-multilayered structure comprises a nano-multilayered coating system.

20. The component of claim 12, wherein the high-temperature component comprises a component of a gas turbine or an aircraft engine.

21. The component of claim 12, wherein the substrate comprises at least one of a nickel-based superalloy, a cobalt-based superalloy, an iron-based superalloy, and an MCrAlY alloy, wherein M comprises at least one of nickel, cobalt, iron and a combination thereof.

22. A method for manufacturing a nano-multilayered structure suitable for use in high-temperature applications, comprising:

providing a substrate having a surface;

disposing a plurality of metallic alloy layers adjacent to the surface of the substrate, wherein the thickness of each of the plurality of metallic alloy layers is on a nano scale; and

disposing a plurality of ceramic oxide layers adjacent to the surface of the substrate and between the plurality of metallic alloy layers in an alternating manner, wherein the thickness of each of the plurality of ceramic oxide layers is on a nano scale.

23. The method of claim 22, wherein each of the plurality of metallic alloy layers comprises a material selected from the group consisting of nickel aluminide, nickel aluminide doped with Hf, nickel aluminide doped with Zr, platinum aluminide and an MCrAlY alloy, wherein M comprises at least one of nickel, cobalt, iron and a combination thereof.

24. The method of claim 22, wherein each of the plurality of ceramic oxide layers comprises at least one material selected from the group consisting of alumina, yttria, zirconia, yttria-stabilized zirconia, hafnia, a yttrium-based garnet and mullite.

25. The method of claim 22, wherein the thickness of each of the plurality of metallic alloy layers and each of the plurality of ceramic oxide layers is between about 3 nm and about 200 nm.

26. The method of claim 25, wherein the thickness of each of the plurality of metallic alloy layers and each of the plurality of ceramic oxide layers is between about 10 nm and about 100 nm.

27. The method of claim 22, wherein the collective thickness of the plurality of metallic alloy layers and the plurality of ceramic oxide layers is between about 5 microns and about 150 microns.

28. The method of claim 27, wherein the collective thickness of the plurality of metallic alloy layers and the plurality of ceramic oxide layers is between about 5 microns and about 150 microns.

29. The method of claim 22, wherein the nano-multilayered structure comprises a nano-multilayered coating system.

30. The method of claim 22, wherein the substrate comprises a component of a gas turbine or an aircraft engine.

31. The method of claim 22, wherein disposing the plurality of metallic alloy layers adjacent to the surface of the substrate comprises depositing the plurality of metallic alloy layers adjacent to the surface of the substrate using a physical vapor deposition technique.

32. The method of claim 31, wherein the physical vapor deposition technique comprises a technique selected from the group consisting of electron beam-physical vapor deposition, cathodic arc coating, ion plasma coating and sputtering.

33. The method of claim 22, wherein disposing the plurality of metallic alloy layers adjacent to the surface of the substrate comprises depositing the plurality of metallic alloy layers adjacent to the surface of the substrate using a thermal sparying technique.

34. The method of claim 33, wherein the thermal spraying technique comprises a technique selected from the group consisting of flame spraying, plasma spraying and high velocity oxygen fuel spraying.

35. The method of claim 22, wherein disposing the plurality of metallic alloy layers adjacent to the surface of the substrate comprises depositing the plurality of metallic alloy layers adjacent to the surface of the substrate using a chemical vapor deposition technique.

36. The method of claim 22, wherein disposing the plurality of ceramic oxide layers adjacent to the surface of the substrate and between the plurality of metallic alloy layers in an alternating manner comprises disposing the plurality of ceramic oxide layers adjacent to the surface of the substrate and between the plurality of metallic alloy layers in an alternating manner using a physical vapor deposition technique.

37. The method of claim 36, wherein the physical vapor deposition technique comprises a technique selected from the group consisting of electron beam-physical vapor deposition, cathodic arc coating, ion plasma coating and sputtering.

38. The method of claim 22, wherein disposing the plurality of ceramic oxide layers adjacent to the surface of the substrate and between the plurality of metallic alloy layers in an alternating manner comprises disposing the plurality of ceramic oxide layers adjacent to the surface of the substrate and between the plurality of metallic alloy layers in an alternating manner using a thermal spraying technique.

39. The method of claim 38, wherein the thermal spraying technique comprises a technique selected from the group consisting of flame spraying, plasma spraying and high velocity oxygen fuel spraying.

40. The method of claim 22, wherein disposing the plurality of ceramic oxide layers adjacent to the surface of the substrate and between the plurality of

metallic alloy layers in an alternating manner comprises disposing the plurality of ceramic oxide layers adjacent to the surface of the substrate and between the plurality of metallic alloy layers in an alternating manner using a chemical vapor deposition technique.

41. The method of claim 22, wherein the substrate comprises at least one of a nickel-based superalloy, a cobalt-based superalloy, an iron-based superalloy, and an MCrAlY alloy, wherein M comprises at least one of nickel, cobalt, iron and a combination thereof.

42. The method of claim 22, further comprising the step of heat treating the nano-multilayered structure at a predetermined temperature.

43. The method of claim 42, wherein the predetermined temperature is in a range of between about 600°C to about 1400°C.

44. The method of claim 43, wherein the predetermined temperature is in a range of between about 600°C to about 1400°C.

45. The method of claim 42, wherein the step of heat treating the nano-multilayered structure at a predetermined temperature comprises heat treating the nano-multilayered structure at a temperature of up to about 80% of the melting temperature of the nano-multilayered structure.